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Title: The Impact of the Institutions on Regional Unemployment Disparities in Europe

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The Impact of the Institutions on Regional Unemployment Disparities in Europe

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Abstract

The main aim of this paper is to study European regional disparities in unemployment, considering regional productive structures and some regional institutional variables. It is widely known that one most important stylized facts concerning the EU consists in regional disparities among regions. Such differences relate to both income per capita and the labour market, the latter generally measured in terms of unemployment rates. In a recent paper (Amendola, Caroleo Coppola, 2004) we have analysed the economic structure of the EU's regions using proxies for the productive structure and the labour market. In this paper we estimate a panel data model where the dependent variable is the regional unemployment rate and the independent variables relate to the productive structure and some regional institutional aspects. The results confirm that institutional variables, such as the centralization of wage bargaining, the decentralization of public expenditure and the level of bureaucracy, have important impacts on unemployment rates.

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Introduction

The problem of regional disparities is a crucial theme in the debate on the economic and political process of constructing the European Union. In fact, if we compare the United States with the European Union, we find that the convergence process is slower in the latter. Moreover, in the same period, disparities among regions have persisted or increased. It is possible to cite numerous examples of the persistence of regional disparities: the unsolved problem of German unification (Marani, 2004), the absence of growth recorded by many less-developed regions in Mediterranean Europe (Caroleo and Destefanis 2005), and the slow transition of the East European countries (Perugini e Signorelli 2004).

The implications in terms of economic theory and policy are of great significance. In fact, no growth theory developed so far, neither for instance the neoclassical theory nor the endogenous theory, nor the new economic geography, are able fully to explain the European case (European Commission 2000; De la Fuente 2000). As regards economic policy aspects, to be noted is that the EU's cohesion policy has been unable to promote economic integration, although this is the prerequisite for the full operation of the European Union's fiscal and monetary policy (Boldrin and Canova 2001; Ederveen and Gorter 2002).

There is almost unanimous agreement in the debate that the institutional and economic conditions regulating the labour market exert major effects on the convergence process. In fact, regional convergence is measured in terms of GDP per capita and/or in terms of the employment rate and productivity level. Econometric estimates confirm that the slow convergence process and the existence of clusters of homogenous regions – internally convergent but mutually divergent – in the EU is caused by employment rate dynamics (European Commission 2004; for a survey see Daniele 2002), and consequently by labour market characteristics. It is consequently important to study the institutional mechanisms that regulate the labour market, as well as the characteristics of labour demand and supply, and their dependence on spatial factors (Nienhur, 2000)

The basic idea of this study is that the regional and/or national disparities in Europe are caused not only by differences among productive structures and the technological and economic conditions that determine employment levels but also by differences among the institutional arrangements that regulate labour markets. In other words, we maintain that these factors may contribute to creating or sustaining the divergence or persistence of disparities among regions. As a consequence a mere implementation of specific development policy designs, although represents the necessary condition for the change, could not resolve the catching up process and, therefore, could not allow late regions to leave the underdevelopment trap. The sufficient condition is that the policy designs could be added with a suitable institutional system.
In the next section we explain why the unemployment rate may be a better indicator of regional labour-market differences. The third section describes the variables chosen to explain the functional relationship among the unemployment rate, as the dependent variable, the productive structure, and labour-market institutions. Then explained is the methodology used to obtain those variables. The last section reports the results of the econometric estimations. The conclusions contain some final remarks.

1. The choice for the dependent variable

As said, studies on economic development and regional convergence regard the employment rate as the variable that seems best able to represent labour market conditions. Since the Lisbon European Council, the European employment strategy itself has set quantitative objectives based on the employment rate. At the same time, an increasing number of studies (Marelli 2004 and 2005; Garibaldi and Mauro 2002) have analysed regional disparities on the basis of this variable.
However, there are two main arguments that justify why we choose the unemployment rate as the dependent variable. First, there is broad consensus on the contention that institutions – implicit or explicit norms and rules, results of agreements between social parts or defined by law - mainly affect unemployment. For example, according to the OECD analysis the 'Eurosclerosis problem' of the 90s was due to institutional rigidities in the European labour market which generated the growth of the structural unemployment rate: that is, an equilibrium rate (NAIRU) to which the labour market converges when, in the absence of exogenous shocks, all prices and wages have been completely adjusted (Layard et al. 1991). Within this theoretical framework, empirical analysis has sought to demonstrate that the different unemployment dynamics of the European countries and, in our opinion, of regions depend mainly on micro-level real labour market frictions, such as the wage bargaining power of workers and/or of unions, information and incentives at firm-level, job search and matching efficiency (Nickell, 1997; Nickell e Layard, 1999; Blanchard and Wolfers, 2000; for a survey see also Caroleo, 2000).
On the other hand, empirical data show that during the 90s the unemployment rate displayed a more marked cyclicity than did the employment rate and that the variability of the unemployment rate at regional level was much higher than that of the employment rate. These stylized facts suggest that analysis of regional disparities should be better focused on the variables that affect the unemployment rate.

2. The independent variables

Elrhost (2000) lists regional variables connected with the labour market that may generate divergence processes among regions. These variables can be summarized as follows: the endowment of production factors and 'fundamentals'; the structure of local labour markets (Genre and Gòmez-Salvador, 2002) in terms of demographic growth, population age-structure, migration, and commuting (Greenway, Upward and Wright, 2002); the employment level; the productive structure (Marelli, 2003; Paci and Pigliaru, 1999; Paci, Pigliaru and Pugno, 2002); demographic density and urbanization (Taylor and Bradley 1997); economic and social barriers; human capital; the institutional structure regulating the goods markets and the labour market; and the wages composition (Pench, Sestito and Frontini,1999; Hyclack and Johnes 1987).

With no claim to exhaustiveness, in what follows we shall test some of the hypotheses outlined above. To this end, we shall estimate the relationship between the unemployment rate, measured at the regional level, and a set of variables that may be classified into three groups: (a) productive structure and labour market indicators, (b) institutional indicators, and (c) variables relative to regional economic performance.

Indicators of the productive structure and labour market

We began by estimating a proxy for the labour market and productive structures of the regions. For this purpose, we calculated two indicators by applying a dynamic multivariate factorial analysis. This method is well suited to the study of multidimensional phenomena like regional disparities because the regions (cases) can be analysed on the basis of a set of indicators (variables) that change over the years (time).

We decided (Amendola, Caroleo, Coppola 2004) to apply the STATIS (*Structuration des Tables A Trois Indeces de la Statistique*) method (Escoufier 1985 and 1987) (see Appendix). This is a dynamic multivariate method able to cluster regions year by year on the basis of a set of variables comprising labour market and income indicators, as well as indicators of the population structure and the structure of the productive sector. It is thus possible to study how the interaction between the labour market structure and economic growth changes over time, and also to analyse the dynamics of regions.

The variables used for this analysis – sometimes based, unfortunately, on relatively crude data that bind us to make use of proxy variables when necessary - are listed in Table 1. They were taken from the Eurostat REGIO database and the European regions database of Cambridge Econometrics Ltd. and they are, as said, indicators characteristic of the labour market and the production system (Wishlade and Yuill, 1997). Labour demand was measured by the employment rate (TOT), while the labour supply was measured by the labour-force participation rate (TAT). The percentage of the long-term unemployed (ULR) was used as a proxy for the structural gap between labour demand and supply. The percentage of part-time employment (PTT) was used as a measure of the flexibility of the regional labour market.

The production system was represented by four variables corresponding to the percentages of employed persons in agriculture (AGR), industry (IND), traditional services – commerce, hotels and non-market services (GHM) – and advanced services – transport, financial services and others (IJA). The other variables considered were population density (DEN), as a proxy for the agglomeration factors of a region (Fujita M. et al., 2001; Krugman P.R., 1991), and per capita income (PPS), which is the indicator most frequently used to represent regional disparities.

Table 1
Variables used in the STATIS analysis

N	Proxy	Variable	Measure	Acr.
1	Agglomeration factors	Population density	Inhabitants /sq km	DEN
2	Labour Supply	total activity rate	labour force/population aged over 15	TAT
3	Labour demand	employment rate	employed/population aged over 15	TOT

4	Structural gap between Labour and Supply	Long-term unemployment rate	long-term unemployed/total unemployed	ULR
5	Flexibility of the regional labour market	part-time employment rate	part-time employed/total employed	PTT
6	Productive structure of the regional economy	percentage employment in agriculture	employed in agriculture/ total employed	AGR
7		percentage employment in industry	employed in industry/total employed	IND
8		percentage employment in traditional services	employed in retail trade, hotels and non-market services /total employed	GHM
9		percentage employment in advanced services	employed in transport, financial and other services/total employed	IJA
10	Regional Economic performance indicator	per capita income	per capita GDP in Purchasing Power Standard	PPS

The European regions (130) selected were disaggregated at a level intended to cover the entire territory and to provide the maximum disaggregation possible with the data available. This level corresponds to the Nuts 2 level for Greece, Spain, France, Italy, Austria and Portugal; Nuts 1 for Belgium, Germany, Holland, Finland, the United Kingdom; Nuts 0 for Denmark, Ireland, Luxembourg and Sweden, for which countries there are no Nuts 1 and Nuts 2 disaggregation. The time period was 1991- 2000.
The STATIS methodology, as said, consists in the analysis of the three-way matrix (tXij), where t denotes the temporal observations, i the regions, and j the variables (i=1,2...I; j=1,2...J; t=1,2...T), obtained by the succession of T matrices ${}_{t}X_{i,j}$ of the same dimensions.
The analysis moves through three phases: interstructure, compromise and infrastructure. The output from the interstructure phase describes the structure of the *T* matrices in a vectorial space smaller than T. In our case this is reduced to two dimensions but still maintains a good similarity to the initial representation. The compromise phase consists in the estimation of a synthesis matrix which yields a representation, in the two-dimensional space identified, of the characteristic indicators and of the average positions of the regions in the time-span analysed (1991-2000). The result of the intrastructure phase is a representation of the trajectories followed by the individual regions in the same period of time.

Table 2
Eigenvalues and inertia percentages of the factorial axes

Axis	Eigenvalue	Variance explained	Cumulated variance explained
1	3.75547	36.76	36.76
2	1.99895	19.56	56.32
3	1.18853	11.63	67.95

Source: Our calculations on Eurostat REGIO data and on the Cambridge Econometrics database

In order to evaluate the goodness of the factorial representation yielded by construction of the compromise matrix, Table 2 shows the first three highest eigenvalues and the percentage of the total variance explained by the first three factorial axes.

To be noted first is that 36.8% of the variance is explained by the first factor, and 19.6% by the second, for a total of 56.3% of the variance expressed by the set of all the variables. In other words, the first factor alone explains more than one-third of the total variability, while the first three factors jointly explain almost 68%. Consequently, the reduction of the phenomenon's variability, obtained by representing it in a two or three dimensional space, is a meaningful synthesis of the information considered.

In order to interpret the two factors, we may refer to Table 3, which shows that minimum and maximum period values of the correlations between the variables and the factorial axes. It will be seen that the variables most closely correlated with the first factor are, on the one hand, the employment rate (TOT), the activity rate (TAT), the percentage of part-time employment (PTT), per capita income (PPS), and the percentage of employment in advanced services; and on the other (positive quadrant), the percentage of long-term unemployment (ULR), and the percentage of employment in agriculture (AGR). In other words, along the first axis one observes a clear polarization between the labour market indicators and those relative to the production structure.

Along the second axis one observes a close correlation among, on the one hand, population density (DEN), per capita income (PPS), and the percentages of employment in traditional services (GHM) and advanced services (IJA), and on the other, the percentage of employment in industry (IND) and in agriculture (AGR), and the employment rate (TOT). In this case, we may state that the second axis identifies in marked manner only the phenomena representing variables located in the positive quadrant, namely those correlated with the territorial dimension. In fact, the indicators in this quadrant represent highly urbanized areas, or ones which contain rail or road infrastructures or sea ports, or with high levels of tourism. The negative quadrant, by contrast, comprises indicators which are more difficult to interpret and concern a mix of factors, such as low population density, the presence of agricultural employment, and high levels of industry (Amendola, Caroleo, Coppola; 2004).

Table 3 Correlations between the variables and the factorial axes (minimum and maximum period values)								
Factor 1			Factor 2			Factor 3		
	Min	Max		Min	Max		Min	Max
TAT	-0.83	-0.75	IND	-0.51	-0.47	IND	-0.77	-0.71
TOT	-0.78	-0.72	TOT	-0.42	-0.37	PPS	-0.36	-0.27
PTT	-0.76	-0.69	AGR	-0.36	-0.34	ULR	-0.18	0.07
PPS	-0.69	-0.63	TAT	-0.34	-0.30	GHM	-0.09	-0.04
IJA	-0.66	-0.64	PTT	-0.11	-0.03	TOT	0.14	0.25
IND	-0.34	-0.22	IJA	0.27	0.30	IJA	0.14	0.20
DEN	-0.30	-0.29	ULR	0.30	0.38	DEN	0.15	0.16
GHM	-0.17	-0.07	PPS	0.33	0.36	TAT	0.19	0.32
ULR	0.58	0.64	GHM	0.64	0.73	PTT	0.21	0.33
AGR	0.70	0.72	DEN	0.73	0.73	AGR	0.47	0.49
Source: Our calculations on Eurostat REGIO data and on the Cambridge Econometrics database								

In conclusion the European regions seem to lie along the two factorial axes that represent certain characteristics of the labour market and the productive structure. The first factor (**FF**) can be interpreted as being a proxy for the ‘bad’ performance of the labour market. It should be pointed out that the variable has an opposite sign with respect to the development indicator: the regions that achieve a good performance in terms of activity rate and employment rate, and higher per capita income levels, have negative values for this factor. By contrast, those regions that have high long-term unemployment rates and high percentages of employed in agriculture have positive values.

The second factor (**SF)** may be interpreted as a factor that is positive correlated with urbanization and a highly developed tertiary sector.

Institutional Variables

If the first factor obtained by STATIS can be interpreted as the labour market’s level of efficiency and flexibility, further indicators of the rigidity/flexibility of the labour market are the degree of decentralization of its regulatory institutions and, particularly, the level of wage bargaining centralization (Calmfors, 1993; Calmfors and Driffil, 1988).

For the purposes of our analysis, the best proxy for the institutional decentralization of the labour market would have been not only a variable related to the level of decentralized bargaining but also the extent to which the industrial relations system is regionally organized. Industrial relations concern the system of employment protection which provides security against (i) the risk of future unemployment and job precariousness, (ii) barriers to human capital development, (iii) restriction of the right to work, and (iv) obstacles to worker representation. These components of the industrial relations system should be adjusted according to the characteristics of local labour markets. Furthermore, active labour market policies, even if centrally determined, in a number of European countries are aimed at implementing arrangements appropriate to particular local labour market characteristics and also involving several local actors and local procedures.

Unfortunately, homogeneous data at the European level were not available. We could consequently only use the standard indicator of bargaining centralization (**CENTR**), which combines the levels of wage bargaining centralization and of wage coordination among the most important trade unions (Checchi and Lucifora 2002; Boeri, Brugiavini and Calmfors 2002). The underlying hypothesis was that the more the bargaining on wages takes place at the level of the individual firm, the more account must be taken of that firm’s productivity level, given that it is necessarily affected by the local economic conditions.

A further institutional aspect considered in our analysis was the administrative decentralization of the public administration. We chose two indicators for this aspect: the first was the degree of centralization of public expenditure (**CFG)** (source IMF 2003); the second is an index of bureaucracy **(BUREAUCRACY)** (see: www.countrydata.com). The former is calculated as the ratio between expenditure by the central administration and total public expenditure. The lower this ratio, the higher will be the percentage of expenditure by the local administration. This ratio represents, in our opinion, a good proxy of the decentralization of public expenditure powers to the regional level. The index of bureaucracy is disaggregated at national level and can be considered a proxy of the public administration's efficiency.

Variables for the economic performances of regions
The third group of variables comprised two widely-used regional development indexes: the percentage variation of the Gross Value Added at constant price (**GRPR**) and per capita investment, measured as investment per inhabitant (**INVPOP**).

Table 4
List of the independent Variables

Acronym	**Variables**
CONS	Constant
FF	Index factor of the labour market's performance *(the variable has an opposite sign related to development's index)*
SF	Index factor of tertiary/urbanization
CENTR	bargaining centralization index
CGF	level of public expenditure centralization
BUREAUCRACY	Bureaucracy index
GDPG	GDP annual growth at constant price
INVPOP	investment/population

3. The Estimation Method: The Panel Data analysis

Our dataset was a Panel where the cases were regions and the time units were the years from 1991 to 2000. We accordingly used panel data econometric methods in order to study the relationship between the unemployment rate and the set of independent variables.
The model may be written as

$$y_{it} = \alpha_0 + x_{it}^{'}\beta + z^{'}\alpha + \varepsilon_{it} \quad [1]$$

where $i = 1,.......n$, $t = 1,..........T$. a_0 is the constant, β is the vector of coefficients, x_{it} contains *K* regressors and the matrix z_{it}, is a set of non-observable variables that captures the specific effects due to the characteristics of the individuals, which in our study were 109 European regions -twenty-one regions were excluded from the econometric analysis because the CENTR variable was not available form them, ε_{it} is the error term.

The variables in z_{it} are not observed and may be correlated or not correlated with the regressors. In the former case, in model [1] the intercept is group specific and is constant over time. This is the Fixed Effects model and may be written as:

$$y_{it} = a_0 + x_{it}^{'}\beta + \alpha_i + \varepsilon_{it} \quad [2]$$

In the latter case, the model is defined as a Random Effects model. The variables of the matrix z_{it} are unobservable and uncorrelated with the x_{it}. In this case the model becomes

$y_{it} = \alpha_0 + x_{it}^{'}\beta + u_i + \varepsilon_{it}$ [3]

where u_i is the group-specific stochastic term.

The difference between the fixed effect and the random effect model resides in the nature of the individual component α_i (in the fixed model) and u_i in the random model. In the fixed effects model, α_i is deterministic and captures the individual's characteristics. It assumes different values for each single individual; it is constant over time; and because it is related to the characteristics of the individual, it is correlated with the variables x_i. In the Random Effects model, the term u_i has a group specific random distribution. The term u_i is a stochastic variable and is not correlated with the x_i because these variables are not stochastic.

The Fixed Effect model is useful for territorial – inter-country or inter-regional – comparisons, as in our case, because it can be plausibly supposed that the non-observed characteristics captured by the variables are constant over time (Green, 2003). However, it is possible to determine which is the better specification – fixed effect or random effect – by using the Hausmann test.

The model estimated is as follows:

$$UNRATE_{it} = a + \beta_1 FF_{it} + \beta_2 SF_{it} + \beta_3 GDPR_{it} + \beta_4 INVPOP_{it} + \beta_5 BUREAUCRACY_{it} + \\ + \beta_6 CENTR_{it} + \beta_7 CGF_{it} + \beta_8 CGF2_{it} + \nu_i + \varepsilon_{it}$$

where a is the constant, $\beta_1 ......\beta_8$ are the parameters, υ_i is the individual component and ε_{it} the error term. The acronyms of the variables are reported in the above list. The variable that measures the level of public expenditure centralization (CFG) is also considered in its quadratic form (CFG2) in order to test the hypothesis of a quadratic relationship of this variable with the unemployment rate and, consequently, the existence of an optimal dimension in the degree of centralization of public expenditure.

Results

Table 5 sets out the results. Reported in the third and fourth columns are respectively the Random Effects and the Fixed Effects estimates. For the sake of completeness, this table also includes the OLS estimation (column 1), and the Random effect model is obtained by using the Maximum Likelihood Estimation (columns 1).

The signs of the coefficients obtained with the four estimation methods are always the same. The Hausmann test rejects the null hypothesis of absence of correlation between the dependent variables and the error terms. This is the fundamental hypothesis of the random effects model, and because it is rejected, we may conclude that the Fixed Effect model is the well-specified model.

The result confirms the theoretical hypotheses formulated in the previous sections. In particular, the coefficients in the Fixed Effect Model are all statistically significant and they have the expected sign. Only the variable GDPR – the annual growth rate of gross value added per capita – is significant only at the 8% level.

The dependent variables are expressed in different measures. Accordingly, in order to compare the magnitude of their effects on the unemployment rate, we calculated the standard coefficients of the variables and the elasticity to their mean value (tab. 6).

Summary and conclusions

The results obtained seem to confirm our initial hypothesis: namely that the unemployment rate is correlated with the extent to which wage bargaining is decentralized, with the institutional efficiency of regions, and also with the bureaucracy level, although the impact of this last variable on the unemployment rate is small.

The centralization level of the public expenditure has a quadratic relationship with the unemployment rate. This means that the unemployment level grows together with the degree to which public expenditure is centralized, but in a less than proportional way, until the value of the centralization ratio is equal to 75%. Above that value unemployment decreases. Nevertheless, we should be cautious in interpreting this result because the signs of the variables CGF and CFG2 are the opposite in the OLS Method.
Also the economic performances of regions – measured by GDP growth and investment per capita (INVPOP) – have negative impacts on unemployment rates. The latter variable has a standard coefficient which is double that of the former.
Also interesting are the values of the two structural factors coefficients. As to be expected, the unemployment rate is negatively correlated with the good performance of the regional labour market (high activity and employment rate, high share of employment in the industrial and advanced services sectors) measured by the first factor (FF).
It is more difficult to explain the positive relationship between the unemployment rate and the second factor, which relates to the large share of services and high demographic density. In this case the results seem to confirm the empirical evidence – as also reported in the third Progress Report on Economic and Social Cohesion in the EU – that "*cities act as centres of employment for a widely-drawn population, with one in every three jobs being taken by someone commuting into the city*" (Commission of the European Communities, Third Progress Report on Cohesion, page 22). For this reason, unemployment and social problems in the European Union are more severe in urban centres, as well as in regard to the tertiarization process now characterizing economic development in the EU.

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Table 5
Results of the Panel Data Estimation Dependent Variable: Unemployment rate

	(1)		(2)		(3)		(4)	
	OLS		MLE		Random Effects		Fixed Effects	
	coefficient	P-level	coefficient	P-level	coefficient	P-level	coefficient	P-level
CONS	10.763	0.01	-16.871	0.00	-12.303	0.00	-24.931	0.00
FF	2.233	0.00	1.706	0.00	1.849	0.00	1.183	0.00
SF	1.388	0.00	1.784	0.00	1.578	0.00	2.633	0.00
GDPR	0.181	0.00	-0.046	0.02	-0.044	0.04	-0.037	0.08
INVPOP	-0.002	0.01	-0.002	0.00	-0.002	0.00	-0.001	0.00
BUREAUCRACY	2.646	0.00	1.855	0.00	2.064	0.00	1.558	0.00
CENTR	-0.083	0.00	0.047	0.00	0.029	0.01	0.077	0.00
CGF	-0.179	0.02	0.528	0.00	0.402	0.00	0.753	0.00
CFG2	0.001	0.13	-0.004	0.00	-0.003	0.00	-0.005	0.00
Num. obs.	1090		1090		1090		1090	
Num. groups			109		109		109	
R2	0.5777							
R2corr	0.5746							
F(8,1081)	184.87	0.00						
Log likelihood			-2399.9584					
LR chi2(8)			378.58	0.00				
R-sq within					0.2704		0.2929	
R-sq between					0.4689		0.2909	
R-sq overall					0.4466		0.2861	
Random effect u_i								
Corr(u_i,X)					0		-0.392700	
Sigma u					3.1659		5.289283	
Sigma e					1.7714		1.771356	
Rho (% of the variance due to u)					0.7616		0.899155	
Wald chi2(8)					479.46			
F(8,973)							50.39	0.000
Hausmann Test (Ho : corr (ui, X)=0) CHI2 (8); Prob>CHI2							113.92	0.000

Table 6
Mean, Standard deviation *(s.d)*,
parameters (fixed effect), standard coefficients (*s.c.*), elasticity at mean value *(el.)*

Variable	*Mean*	*s.d .*	*parameter*	*s. c.*	*El.*
UNEMPLOYMENT RATE	10.885	6.064			
CONSTANT			-24.931		
FF	-0.300	1.766	1.183	0.344	-0.033
SF	0.171	1.384	2.633	0.601	0.041
GDPR	2.029	3.260	-0.037	-0.020	-0.007
INVPOP	50.239	178.694	-0.001	-0.044	-0.007
BUREAUCRACY	3.974	0.143	1.558	0.037	0.569
CENTR	25.747	16.247	0.077	0.207	0.183
CGF	73.082	8.256	0.753		
CGF2	5409.132	991.429	-0.005	0.199	0.289

APPENDIX

STATIS is a method based on study of a three-way data matrix $X_{I,JT}$ obtained from the temporal succession of data matrices ${}_tX_{i,j}$ of the same order, where i is the statistical unit and j the variable, both of them relative to the period t (i = 1, 2...I; j = 1, 2...J; t=1, 2...T). The formula is:

$$\mathrm{X}_{I,JT} = \left\| {}_1X \quad {}_2X \quad {}_TX \right\|$$

From the three-way matrix thus constructed it is possible to derive:

1) the variance-covariance matrix ${}_{pq}\Sigma$ that is the variance-covariance matrix between pXi,j and qXi,j :
The matrices on the main diagonal represent the variance-covariance matrices of the matrix $\mathrm{X}_{I,JT}$ at time t, while ${}_{pq}\Sigma$ measures the same relation between the variables relative to time q and time j.

2) the (TxT) square matrix, $I_{T,T}$ where each generic element $I_{p,q} = tr({}_{pq}\Sigma)$ corresponds to the trace of the relative submatrix ${}_{pq}\Sigma$ of $\Sigma_{JT,JT}$ and it is a measure of the dissimilarity between pXi,j /and qXi,j.
The STATIS method divides into three phases: Interstructure, Compromise and Intrastructure.
The purpose of the Interstructure phase is to identify a suitable vectorial space smaller than T, where the T occasions can be represented.

To this end, examination is made of the matrix $I_{T,T}$ (the interstructure matrix), the column vectors of which are assumed as characteristic elements of each of the T occasions. Constructed from this is a factorial subspace $\Re^s$ with s < t generated by the s eigenvectors corresponding to the s largest eigenvalues of $I_{T,T}$. The subspace thus constructed yields the best representation of the T occasions because it is demonstrated that the matrix Q, of rank $s < T$ – whose elements $Q_{(s)} = \sum_{a=1}^{s} \delta_a u_a u_a^{'}$ are linear combinations of the first δ_a eigenvalues and u_a eigenvectors of the matrix $I_{T,T}$ - has the characteristic of minimizing the square of the Euclidean norm || I-Q ||^2.

A first result is thus obtained. The T occasions with coordinates equal to $\sqrt{\delta_1 u_1}$, $\sqrt{\delta_2 u_2}$,.......... $\sqrt{\delta_h u_h}$ can be generated in the factorial subspace $\Re^s$ by the first eigenvectors u_a .
In the compromise phase, a fictitious structure or synthesis matrix is identified which optimally summarizes the information contained in the T variance and covariance matrices. This structure, called 'compromise', is given by the matrix W obtained as a linear combination of the elements u_1 of the eigenvector of the matrix $I_{T,T}$ corresponding to the highest eigenvector and the matrices $\Gamma_t = {}_t\hat{\mathrm{X}}_t\hat{\mathrm{X}}'$ (Escoufier, 1979, p. 113):

$$W = \sum_{t=1}^{T} u_t \Gamma_t$$

In the space plotted by the s eigenvectors corresponding to the first s eigenvalues of the matrix W it is possible to represent both the j variables and the median positions of each individual. The latter are derived from the diagonalization of matrix W obtained by identifying a matrix M such that W = MMD (where D is a diagonal matrix defined positive whose elements are the weights of the individuals, statistical units, $D = \frac{1}{L} I$, with L equal to the number of individuals, and where I is an identity matrix.
In other words, matrix W is the best compromise, in the sense defined above, among the various representations that can be associated with each of the T matrices taken separately for each unit of time.
In the intrastructure phase it is then possible to represent the trajectories followed in time by each individual in the factorial space thus identified. If only the first two eigenvalues are considered, the representation of the trajectories may occur in a space where the system of Cartesian axes is constituted by the eigenvectors a_1 a1 and a_2 a2, and where the coordinates on the first axis of each individual are given by $(\delta_{1t} \Gamma a_1)^{-0.5}$ and on the second axis by $(\delta_{2t} \Gamma a_2)^{-0.5}$.

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